Transport Canada Transports Canada

TP 1624

Marine Casualty Investigations

Enquêtes sur les accidents maritimes

Investigation Report to the Minister pursuant to sections 477 or 480 of the Canada Shipping Act (1985)

Rapport d'investigation au Ministre conformément aux articles 477 ou 480 de la Loi sur la marine marchande du Canada (1985)

Canada

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Ce rapport est aussi disponible en français

REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE EXPLOSION ON BOARD THE NORWEGIAN VESSEL "POLLUX" CAUSING THE DEATH OF TWO CREW MEMBERS AND INJURING TWELVE OTHER PERSONS ON MARCH 19, 1990, AT LA BAIE, QUEBEC.

RAPPORT No. 551

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Effective March 29, 1990 the mandate to conduct investigations into Marine occurrences was transferred to the Transportation Safety Board of Canada (TSB) - Investigations Marine. In accordance with the Act establishing this new organization, outstanding investigations conducted under the Canada Shipping Act prior to this date are being completed and distributed by TSB - Investigations Marine.

Depuis le 29 mars 1990, le Bureau canadien de la sécurité des transports (BST) - Enquêtes - Maritimes, a reçu le mandat de mener les enquêtes sur les accidents maritimes. Conformément à la loi créant ce nouveau Bureau, les enquêtes en cours prévues par le Loi sur la marine marchande seront terminés et les rapports distribués par le BST - Enquêtes Maritimes.

REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE EXPLOSION ON BOARD THE NORWEGIAN VESSEL "POLLUX" CAUSING THE DEATH OF TWO CREW MEMBERS AND INJURING TWELVE OTHER PERSONS ON MARCH 19, 1990, AT LA BAIE, QUEBEC.

Particulars of Vessel

Name	"POLLUX", formerly the "BALTIKUM"
Official No. (D.N.V.)	10846
Flag	Norwegian
Port of Registry	Alesund
Call Sign	LA1Q2
Gross Tonnage	11,903
Net Tonnage	6,360
Length Overall	155.8 m
Breadth	22.5 m
Moulded Depth	13.970 m
Type	General cargo
Built	1977, steel, Haugesund Shipyards, Norway
Propulsion	One 6-cylinder Sulzer diesel engine generating 12,000 hp, driving a single controllable-pitch propeller
Cargo	Potlining or spent potlining
Crew	22
Classification	Det Norske Veritas
Owners	BHT Pollux Shipping Inc.
Operators	Nomadic Shipping
Charterers	Groupe Desgagnés Inc. Quebec, Canada
Agent	Alcan Shipping Quebec, Canada

Victims

Name:	Egualan, Crispin C.
Position on board vessel:	Second Officer
Age:	38 years
Place of Birth:	Antique
Nationality:	Filipino

Name:	Rodil, Reynaldo E.
Position on board vessel:	Able Seaman (AB)
Age:	45 years
Place of Birth	Cavite
Nationality:	Filipino

Seriously Injured

Name:	Guanio, Rolando P.
Position on board vessel:	Ordinary Seaman (OS)
Age:	38 years
Place of Birth:	Pangasinan
Nationality:	Filipino

Note: All times in this report are expressed in Eastern Standard Time (UTC minus five hours).

Background

On March 19, 1990, at approximately 1425 a violent explosion took place in hold No. 1 of the Norwegian vessel "POLLUX". At the time of the explosion, the vessel was moored at the Powell Dock of the Alcan harbour facilities at La Baie, Quebec. Commencing March 13, 1990, the ship had been loading a bulk cargo of spent potlining. At the time of the explosion, hold No. 1, which already held some 2,150 mt of spent potlining, had been closed and unventilated since 1140, March 15, 1990.

The explosion caused the deaths of two crew members and serious injury to another. Ashore, 11 other people were injured, to various degrees, by debris and other objects propelled by the explosion's shock wave.

The sound of the explosion was audible beyond a one-kilometre radius from the site. The "POLLUX" sustained heavy damage in the area around hold No. 1. The Powell Dock harbour facilities, as well as residences and businesses in La Baie located close to the site of the explosion, were also damaged. Two harbour tugs, docked just ahead of the vessel, sustained heavy damage from two No. 1 hatch cover panels weighing a total of 30 tons which were propelled into the air over the bow of the ship by the explosion.

Repair costs for the "POLLUX" have been estimated at some US$5,500,000, and for the tugs "ALEXIS SIMARD" and "GRANDE BAIE" at $819,000 and $84,000 respectively; other claims totalling some $20 million have been filed.

Brief Description of Vessel

The "POLLUX", under the Norwegian International Ship Register, is 155.8 m long and was built at the Haugesund shipyards in Norway in 1977. She was built under the supervision of DNV (Det Norske Veritas) and classed Finnish Ice Class IA Super.

The accommodation, bridge and engine-room are located aft. Forward of the accommodation there are 3 hatches serving 5 holds which are completely open underdeck when the tween-decks are retracted to the ship's side. This vessel was specially designed for transporting newsprint, general cargo and other bulk cargo such as grain and forest products.

Each hold is equipped with a series of fans capable of changing the air inside the holds between 25 and 30 times an hour when the hold is empty. The air can be recirculated and the fans are reversible. All the holds are linked to a carbon dioxide extinguishing system and are also connected to a smoke detector panel on the navigation bridge.

At the time of the explosion, all the tween-decks were retracted to form an open hold underdeck. All the ventilation outlets and the accesses at the tween-deck level and the bottom of the hold were covered to prevent them from becoming filled with the bulk spent potlining.

Narrative

On March 12, 1990, at approximately 2200, the vessel "POLLUX" arrived from Falmouth in ballast at the Powell Dock of the Alcan harbour facilities at La Baie, Quebec. The harbour authorities went on board and informed the master that 15,500 mt of spent potlining would be loaded, and that loading would take place day and night. No other specific instructions were communicated to the vessel regarding the cargo. However, special trucking procedures were in effect as for handling a cargo of toxic products. Nevertheless, there were no signs on the dock or in the vicinity of the vessel to warn of the handling of a dangerous substance.

The holds and bilges were cleaned and dried. The ventilation outlets and the accesses to the holds were covered so as to prevent cargo dust and residue from spreading into the fan rooms situated forward and aft of every hold. A "No Smoking" sign had been posted near the main deck by the crew and "No Smoking" signs were permanently affixed on the insides of the hatches in each hold.

Loading began the next morning, March 13, 1990, into hold No. 2 of the "POLLUX". The transportation of this spent potlining from its storage site in Jonquière to the Alcan harbour facilities was conducted in accordance with the Quebec Provincial hazardous waste regulations, and a transportation permit was issued by Environment Quebec to a local trucking company. According to the trucking manifest, the spent potlining was a solid hazardous toxic material. According to a 1988 data sheet issued by Alcan, spent potlining forms gases on contact with water. When loading began, the vessel, the charterers and the owners were unaware that this cargo was classified by some authorities as being toxic and hazardous.

The transportation and loading of the spent potlining proceeded as follows:

- a fleet of trucks transported four metal containers each filled with some 8 mt of spent potlining;

- at the Powell Dock, the containers were lifted off the trucks, transported by fork-lift and deposited on the wharf;

- each container was then hoisted on board using the ship's crane and emptied into the hold.

Throughout the day of March 13, loading proceeded through hatch No. 2, i.e. into No. 2 and No. 3 holds. The following day, March 14, at approximately 0800, there were some 1,800 mt of spent potlining stowed in holds No. 2 and No. 3 of the "POLLUX". During the morning of the 14th, hatch No. 1 was opened and loading began through it. Except for a brief pause due to a breakdown of a ship's crane, the loading of spent potlining into hold No. 1 continued until 1140 on March 15. However, during the day of March 14 while the spent potlining was being loaded into hold No. 1, there was approximately 8 mm of rainfall. The master, concerned about the cargo, contacted the harbour authorities for information and was assured that the cargo was simply a waste product and that there was no danger. Hatch No. 1 was closed on March 15 at or about 1140 with approximately 2,150 mt stowed in this hold and it remained closed until the explosion on March 19, 1990. All the spent potlining stowed in holds No. 1, No. 2 and No. 3 from the start of loading to this point in time came from an outdoor storage site at Jonquière. Loading subsequently proceeded in all the other holds except hold No. 1 with spent potlining from inside a building at the Jonquière site.

While loading proceeded, the vessel, which had arrived with water ballast, began emptying her tanks. Tank soundings are taken in the fan rooms located at either end of the holds, but the crew members would not enter the rooms to take soundings because of the

very strong ammonia odour. Some crew members, feeling ill because of this ammonia odour, wore face masks when working outside the living quarters. Because of this strong ammonia smell the master advised the chief officer to prohibit crew members from entering the fan rooms.

During the afternoon of March 19, loading proceeded into holds No. 4 and No. 5, and by this time, there were approximately 11,550 mt of spent potlining already stowed in the holds of the "POLLUX". During this time, crew members were occupied with various routine tasks, such as cleaning up a small spill of used oil on the starboard afterdeck which occurred when the oil was being transferred from the vessel to a tank truck.

For reasons of the vessel's trim, the master directed the officer of the watch - the second officer - to open hatch No. 1 by 1600 so as to resume loading into this hold. At approximately 1420, the second officer informed the first officer of the master's intention to open hatch No. 1. This hold had been closed since noon on March 15. While heading towards hatch No. 1, the second officer, accompanied by an able seaman (AB), approached an ordinary seaman (OS) and asked him to also come forward to assist in opening the hatch. The boatswain, however, countermanded the second officer's order and directed the ordinary seaman (OS) to remain at his station and to continue cleaning the deck. He told the second officer that he - the second officer - and the seaman of the watch were sufficient crew in order to open hatch No. 1.

On deck at the time were the longshoreman crane operator at the controls of crane No. 4 at hold No. 3, an ordinary seaman (OS) working inside the forecastle, and the boatswain with a seaman aft near the accommodation. The second officer headed forward with an able seaman (AB), probably to carry out the order to open hatch No. 1.

At approximately 1425 there was a violent explosion in hold No. 1 and debris was hurled into the air. Two hatch No. 1 cover panels were thrown up into the air and landed forward of the vessel on two harbour tugs, heavily damaging them. The jib of the hatch No. 1 crane flew off into the air and landed on hatch No. 2. Meanwhile, the "POLLUX" was shuddering with the shock of the explosion and all the crew members moved quickly to the dock. The lifeless body of the able seaman (AB) was found on the dock abeam of hatch No. 1. The body of the second officer was found among the debris on the vessel's deck on the starboard side, not far from the controls for the hydraulic hatch-opening system. A seaman who was in the forecastle at the time of the explosion was found seriously injured near hatch No. 1. He was quickly attended to by harbour rescue workers and taken to hospital.

After shutting down all machinery on board the "POLLUX" at approximately 1450, crew members who had returned on board left the totally incapacitated vessel. The Alcan harbour site was immediately evacuated and a control zone of approximately 700 m was established. Access to the area was prohibited for several days, except to Alcan specialists, the Coast Guard, the town of la Baie emergency team and the Ministry of the Environment. The paper company building lying within this zone was also evacuated for several days.

Analysis

1. Ship's papers

At the time of the explosion, the "POLLUX" was under Norwegian International Registry. All the ship's papers were in order, and all the officers duly qualified.

2. Navigational aids and on-board instruments

All navigational aids and on-board instruments and the radio communication system were in good working order.

3. Propulsion system

The propulsion system and all other machinery on board the "POLLUX" were in good working order. At the time of the explosion, the boiler was being worked on in preparation for an inspection but this fact was not related to the explosion.

4. Location of vessel at time of explosion

At the time of the explosion on March 19, 1990, the Norwegian vessel "POLLUX" was berthed starboard side-to at the Alcan harbour facilities. She was moored at berth No. 1 of the 346.8-metre-long Powell Dock in a charted 10 m of water. On the dock there is a handling shed 304.8 m long by 15.2 m wide and nearby there is a paper warehouse belonging to the Stone Consolidated company. The Powell Dock is served by the Roberval Saguenay Railway.

At the time of the explosion, the "POLLUX" was loading a cargo of spent potlining and was moored at a private dock within the waters of Baie des Ha! Ha! under the jurisdiction of Ports Canada. The Sailing Directions, Gulf and River St. Lawrence, under the heading "Regulations", state that: "as a Ports Canada harbour, vessels manoeuvring or otherwise underway in the harbour, and also while at an alongside berth or at anchor, are subject to the Ports Canada Operating By-Law."

5. Weather conditions

The explosion on board the "POLLUX" occurred at approximately 1425 on March 19, 1990. At approximately 1400, the following weather conditions were noted by the weather observers at CFB Bagotville, which is 1.5 kilometres in a direct line WNW from the scene of the explosion:

- wind from the NW at a speed of 8 knots;
- barometric pressure of 1021.5 mb and rising;
- air temperature of -2.6°C;
- relative humidity of 56%;
- visibility 15 miles;
- 5/10 scattered cloud.

6. Details about cargo

The smelting of aluminum employs an electrolytic cell part of the inside of which is made up of a cathode unit. This cathode lasts approximately 5 to 6 years. During its years of use, the cathode, i.e. the carbon, increases in volume and weight through absorbing aluminum and other substances. Over time, the cathode deteriorates and is replaced. The spent cathode is then placed in a quenching bath so as to release hydrogen and methane gas and soften the material before breaking it into pieces for ease of disposal. This residue, or spent cathode or carbon waste, then becomes what is termed "spent potlining".

At the time of the explosion this spent potlining product was being shipped by Alcan Smelters and Chemicals Ltd. of Jonquière to Reynolds Metals Co. in Jones Mills, Arkansas, U.S.A. to be neutralized and made inert.

7. Material safety data sheet

Name of product:

- spent potlining

Synonym:

- waste cathode
- spent cathode

The data sheet for spent potlining from Alcan Smelters and Chemicals Ltd. may be summarized as follows:

- the material is a solid, grey-black substance with ammonia odour if wet;

- this substance should not be sprayed with water because it releases ammonia and explosive gases such as hydrogen, methane and acetylene;

- in the presence of acids or at high temperatures the spent potlining releases fluoride, hydrogen fluoride, hydrogen cyanide, and oxides of sulphur.

The data sheet indicates how this substance can affect human health. For example, if inhaled, it can cause severe irritation of the respiratory tract. If it emits high concentrations of ammonia, it can cause bronchial spasms, dyspnea, and chest pains. The gases that are released can cause irritation of the gastro-intestinal tract, nausea and vomiting, and if a large quantity is ingested, death can occur.

Prolonged overexposure to fluoride can increase the radiographic density of bones and teeth, resulting in possible fluorosis. It can also cause respiratory disorders.

Preventive measures indicated on the data sheet may be summarized as follows:

- for personal protection, use local and exhaust ventilation, use a dust respirator, wear protective clothing, use gloves, and change work clothes if they become contaminated;

- for safe handling, keep the material dry and avoid all contact with skin and eyes;

- for safe storage, keep in a cool, dry, well-ventilated location (see attached material data sheet).

8. <u>Stores of spent potlining in Jonquière</u>

A report submitted by Alcan to Environment Québec, stated that there were some 260,000 mt of spent potlining at the Alcan plant site in Jonquière; some of it was stored in a building, and the rest was buried in clay silos on a large tract of factory land. Fearing that cyanide, which is released by spent potlining, might escape into the area's rivers and water table, Environment Quebec recently directed that the spent potlining site be cleared within a few years.

In order to decrease the amount of spent potlining stored at the Alcan plant in Jonquière, it was decided in the fall of 1989 to export some 40,000 mt of the substance, or the equivalent of a year and half's production, to a Reynolds plant in Arkansas, USA, to be neutralized and made inert.

9. **Spent potlining shipment project**

In the fall of 1989, the matter of exporting some 40,000 mt of spent potlining was assigned to the director of Alcan's materials recycling project. A committee was formed to organize the safe transportation of this product. A health and safety committee submitted a report to the director containing recommendations on respiratory tract safety equipment to be used in handling spent potlining - as was planned for March of 1990.

As this cargo of spent potlining was known to be a hazardous waste, the committee had obtained some documents from the Reynolds Company in Baie Comeau on procedures for obtaining an acknowledgement of notification for exporting this hazardous waste. On January 10, 1990, the notification was sent to the Transportation of Dangerous Goods Branch in Ottawa, and on January 31, 1990, authorization was received issued by Environment Canada on behalf of the Director General, Transport of Dangerous Goods Directorate. Meanwhile, Alcan chartered the vessels "POLLUX" and "NOMADIC ARPIA", both of Norwegian registry. The first vessel to arrive in Baie des Ha! Ha! was the "POLLUX" on March 12, 1990 at approximately 2130. Moored at the Powell Dock, she was due to load 15,500 mt of spent potlining and then sail to Burnside, Louisiana, for discharge. There, the cargo was to be transferred from the vessel to barges for transportation up the Mississippi to Little Rock, Arkansas, where it was to be transferred to trucks for the approximately 15-kilometre journey to the spent potlining neutralization plant.

10. **Authorization to export spent potlining**

On January 12, 1990, Environment Canada received the notification regarding the bulk transportation of 40,000.00 mt of spent potlining. After receiving authorization from the United States Environmental Protection Agency, Environment Canada issued Alcan the acknowledgement of notification for the transportation of waste for export, dated January 31, 1990.

On the acknowledgement of notification for the transportation of waste, Environment Canada described this spent potlining as a 40,000.00 mt quantity of a solid, toxic substance. The substance identification number was UN 2811 with a 6.1 IMO

classification and Packing Group 2, i.e., substance toxic if inhaled.

11. **Precautions taken ashore during handling of spent potlining until reaching vessel**

The following is a summary of the precautions taken by the shipper of the spent potlining in loading trucks and transporting the product to the vessel:

- facial respirators to be worn by drivers of mobile equipment inside Building 308;
- half-masks to be worn by truck drivers as protection against ammonia and dust;
- reduction of the longshoreman team to 5 men because of exposure to ammonia and dust;
- transportation of spent potlining by truck from the Jonquière site to the Powell Dock under the supervision of Environment Quebec;
- a hazardous waste manifest for each truck;
- each truck identified as carrying hazardous waste;
- the carrier held a Quebec Environment Department hazardous waste transport permit issued on February 21, 1990;
- periodic air samples taken by a chemist on the dock during loading of the "POLLUX".

12. **No information on cargo passed to vessel**

The shipper, Alcan Smelters and Chemicals Ltd., was in possession of safety data information on spent potlining as well as the precautions to be taken in handling the material. The shipper, however, merely offered the ship-broker a cargo of bulk spent potlining for transportation by sea. The description of the cargo given in the charter party was merely "spent potlining".

No safety information on the cargo of spent potlining was passed to the broker, the charterer or the vessel. However, the shipper was familiar with the cargo of spent potlining and was in possession of the Material Safety Data Sheet for the material prepared by the Alcan Toxicology Service. Unfortunately, this information, although valuable for the safe transport of this cargo by sea, was not supplied to the crew of the Norwegian vessel "POLLUX". Alcan's shipping

agency was also unaware that such a document existed, and it could therefore not supply it to the master when the "POLLUX" arrived at the Powell Dock.

The Code of Safe Practice for Solid Bulk Cargoes, published by the Canadian Coast Guard, stipulates the following:

> Before shipment, the shipper shall provide details regarding the nature of the cargo.

In the foreword to the Code there is a warning to the effect that the list of substances appearing in the Code's appendices is by no means exhaustive. This means that, even though spent potlining is not listed, its data sheet would require it to be considered a hazardous substance.

Before arrival in Canada, the master of the "POLLUX" contacted the shipowners regarding this cargo, with which he was not familiar. The shipowners were also unfamiliar with the cargo, and, in turn, they asked the master to provide them with a report regarding the nature of this cargo. Further, the master consulted the IMO International Maritime Dangerous Goods Code and the Safe Practices for Solid Bulk Cargo Code and found that the cargo was not listed as dangerous goods. Finally, when it rained, the master asked if there was any danger of any kind for the cargo and he was assured by the Alcan port authorities that there was no danger. Loading therefore continued despite the rain.

While it is true that no one on board "POLLUX" could have reasonably foreseen that this cargo was dangerous, there were nevertheless the following signs during loading:

- extremely strong odour of ammonia which forced crew members to wear masks;

- crew members refused to enter the fan room to sound the tanks because of the contaminated air;

- the master ordered the chief officer to prohibit access to all closed compartments on the vessel, also because of this ammonia odour.

These signs should have been sufficient grounds to question the loading of the material and require the shipper to supply information on the physical and chemical properties.

13. <u>Preparation of holds prior to loading</u>

Before the "POLLUX" arrived in La Baie, the holds and all the hold wells had been cleaned and dried. The well strainer

plates were protected so as to prevent the cargo from getting into them. The accesses to the tween-decks and the bottom of the holds were blocked off with plywood so as to prevent the cargo from entering the fan rooms. The ventilation outlets had also been covered with polyethylene so as to prevent dust from entering the fan areas.

When the vessel arrived at the Powell Dock at approximately 2130 on March 12, 1990, a representative of the shipping agent and a customs officer went on board for the routine formalities. The agent advised the master of how long the loading would take, how much spent potlining would be loaded, and that loading was to start the next morning - March 13, 1990. The master then signed various administrative documents and the Notice of Readiness.

The next day, March 13, at approximately 0900, loading began through hatch No. 2, i.e., into holds No. 2 and No. 3. No hold inspection was carried out by an inspector; a foreman merely glanced down inside the holds from the hatches as loading was commencing.

14. Hold ventilation system

Located fore and aft of each hold was a fan room capable of replacing the air inside the hold between 25 and 30 times an hour. The fans were reversible. At the time of the explosion, the ventilation system was not in operation for the reasons given in item 13.

However, the hold ventilation system and the electrical components of the hydraulic system found in some ventilation rooms were not gastight and moreover could give off sparks, particularly when being turned on and off.

If we accept the description of the material given in the data sheet and refer to a clause in the charter party barring certain dangerous cargoes, it would appear that the "POLLUX" was not suitable for transporting a cargo of spent potlining.

15. Distribution of spent potlining aboard vessel

Part of the cargo of spent potlining loaded on "POLLUX" at the time of the explosion came from an outdoor site and the remainder came from inside a building that was mechanically ventilated.

The weight of the cargo was to be determined by assessment of the draught after loading, and it is estimated that at the time of the explosion, the cargo was distributed as follows:

- hatch No. 1 - 2,150 mt;

- hatch No. 2 - 5,400 mt;

- hatch No. 3 - 4,000 mt;

Total: 11,550 mt (approximate).

Loading of the vessel began on the morning of March 13, 1990, into hatch No. 2 and on March 14, at approximately 0620, loading began into hatch No. 1. Loading into hatch No. 1 continued into the next day - until approximately noon on March 15. This hatch was then closed on 2,150 mt of spent potlining from the outdoor site. This hatch remained closed and unventilated until the time of the explosion, i.e. March 19 at approximately 1425.

It is believed that hatches No. 2 and No. 3 contained a mixture of spent potlining from both the outdoor site and from inside the building.

Spent potlining was stored outside after the building was full and was therefore of more recent origin than that stored inside. It is estimated that some 24,000 mt of spent potlining accumulates at the Jonquière site annually. The 2,150 mt loaded through hatch No. 1 came from the outdoor site and was therefore spent potlining of recent origin.

16. <u>Acts, Regulations, Codes and Convention</u>

The Norwegian vessel "POLLUX" was loading a bulk cargo of spent potlining to be transported to a neutralization plant in Arkansas.

Spent potlining is a residue left in electrolytic cells, and according to the data sheet for this material from Alcan Smelters and Chemicals Ltd., its decomposition is hazardous for the following reasons:

a. In the presence of water or alkalis, it releases ammonia and explosive gases such as hydrogen, methane and acetylene.

b. In the presence of acids or at high temperatures, it releases fluoride, hydrogen fluoride, hydrogen cyanide, and oxides of sulphur.

The substance is also toxic if inhaled or ingested and can irritate the skin.

As precautions, it is stipulated that, during handling, the material should be dry and all contact with skin and eyes should be avoided. For storage purposes, the material should

be kept under cover and should be stored in a cool, dry, well-ventilated place.

Classification

(I) The International Convention for Safety of Life at Sea classifies various dangerous substances. The classification given the spent potlining in the pre-shipment documentation was 6.1, and, according to the Convention, this class is for poisonous (toxic) substances only.

The data sheet for this material reveals the substance's toxicity and also the fact that, in contact with water, it emits ammonia and explosive gases. For this reason the material should normally have been classified 4.3, i.e., a substance which, in contact with water, emits flammable gases.

(II) The *Transportation of Dangerous Goods Act*, section 3(5), Application of Act, provides as follows:

> ...this Act does not apply to any handling, offering for transport or transporting of dangerous goods in bulk in vessels within the meaning of the *Canada Shipping Act*.

The same section of the Act defines the term "bulk" in subsection (6) as follows:

> For the purposes of subsection (5), "in bulk" means confined only by the permanent structures of a ship or vessel, without intermediate containment or packaging.

The spent potlining was loaded in bulk on board the vessel and therefore, the *Transportation of Dangerous Goods Act* did not apply. For this reason, the shipper was not required to complete the notification form (for export) for the Transportation of Dangerous Goods Branch in Ottawa, as stipulated in section 4.20.1(1)(a) of the Transportation of Dangerous Goods Regulations. Nor was the issuance by Environment Canada of an acknowledgement of notification for export of this dangerous waste pursuant to section 4.20.1(1)(b) of the same regulations on January 31, 1990, legally necessary.

(III) The *Canada Shipping Act* defines dangerous goods or goods of a dangerous nature as goods that by reason of their nature, quantity or mode of stowage are either

singly or collectively liable to endanger the lives of the passengers or imperil the ship.

The Dangerous Bulk Materials Regulations pursuant to section 389 of the *Canada Shipping Act* state in section 3, Application, that the Regulations apply to materials referred to in section 5. This section reads:

> The materials in solid form, carried in bulk on board a ship, that are listed in column 1 of Schedule I are hereby declared to be dangerous goods.

Schedule I to the Regulations lists 23 types of dangerous materials. This list does not include spent potlining. However, this material had already been recognized as a dangerous material by the Transportation of Dangerous Goods Branch in Ottawa, by Environment Canada and by Environment Quebec when previous shipments had occurred.

Nevertheless, the foreword to the 1984 edition of the Code of Safe Practice for Solid Bulk Cargoes, TP 5761, published by the Department of Transport states:

> ... the list of products appearing in the Appendices of the Code, however, is by no means exhaustive. Consequently, before any bulk cargo is loaded, it is essential to ascertain (normally from the shipper), the current physical and chemical properties of the cargo...

In summary, the loading and transportation of spent potlining on board the Norwegian vessel "POLLUX" was carried out in accordance with the *Transportation of Dangerous Goods Act* rather than with the provisions on the bulk transportation of dangerous goods of the *Canada Shipping Act*. Until the casualty the Ship Safety Branch of the Canadian Coast Guard had not been made aware that such shipments of spent pot-lining were being made by vessel. Furthermore, the shipper did not supply information on the physical and chemical properties to the vessel, the charterer or its shipping agent before loading.

(IV) In accordance with Part IV of the *Canada Labour Code*, the Marine Occupational Safety and Health Regulations did not apply to the Norwegian vessel "POLLUX". These regulations did, however, apply to those loading the vessel. Part VIII of the Regulations, Dangerous Substances, states:

> 8.14 ... where a dangerous substance is stored, handled or used in a workplace, signs shall be posted in conspicuous places warning every person granted access to the workplace of the presence of the dangerous substance and of any precautions to be taken to prevent or reduce any hazard or injury to health.
>
> 8.15 ... every container of a dangerous substance that is stored, handled or used in a workplace shall be labelled, marked or tagged in a manner that indicates clearly:
>
> a) name of the substance; and
> b) dangerous properties of the substance.
>
> 8.16 ... where a material safety data sheet pertaining to a dangerous substance stored, handled or used in a workplace may be obtained from the supplier or manufacturer of the dangerous substance, the employer shall obtain a copy thereof and keep it available for examination by employees in the workplace.

None of these requirements in the above cited regulations were in force in the workplace near the "POLLUX" during the period of loading from March 13 until the time of the explosion.

(V) Following the explosion, on April 5, 1990, the Canadian Coast Guard Board of Steamship Inspection determined that this material was dangercus and, because it was not specifically included in the regulations, issued an initial ruling to the effect that spent potlining should be considered as slag aluminum, with the following precautions:

- Hot or wet material shall not be loaded and that prior to loading, a certificate should be provided by the manufacturer or shipper stating that the material was stored under cover, but exposed to the weather in the particle size in which it is to be shipped, for not less than three days prior to shipment.

- The cargo spaces should be ventilated by at least two mechanical, explosion-proof fans. Ventilation shall be such that any escaping gases cannot reach living quarters or working areas on deck or in the engine-room.

- The cargo must be protected from rain or snow during handling operations.

- Where any quantity of this product is to be carried on a ship, notice of such intention shall be given to the nearest Coast Guard Ship Safety office at least 7 days prior to loading.

- A Steamship Inspector shall inspect the ship for suitability prior to loading and attend periodically during the loading process to ensure all necessary precautions are observed.

Upon review, this initial ruling was amended, and elaborated upon, by the Board of Steamship Inspection; the new ruling was effective July 23, 1990.

(VI) On March 18, 1975, in keeping with a recommendation from the Minister of Transport and in accordance with section 9 of the National Harbours Board Act, Baie des Ha! Ha! was transferred to the National Harbours Board.

At the time of the explosion, the "POLLUX" was loading a cargo of spent potlining. She was berthed at a private dock in the waters of Baie des Ha! Ha! under the jurisdiction of Ports Canada.

According to the National Harbours Board Operating By-Law:

> No explosives or dangerous goods shall be loaded...in a harbour except
>
> a) in a manner satisfactory to the Board; and
>
> b) by persons assigned to and competent to do such work who are under the supervision and in the continuous presence of a person in charge who, in the opinion of the Board, is competent to direct the operation.

In the present case, the Ports Canada authorities had simply not been informed of this loading of spent potlining in the waters of Baie des Ha! Ha! and subsequently, i.e. after the explosion, they were refused access to the site.

17. <u>Laboratory analysis</u>

The investigation conducted into the explosion on board the Norwegian vessel "POLLUX" included laboratory analyses of samples of potlining.

To confirm the release of explosive gas from the potlining, samples were taken by Transport Canada employees from:

- hold No. 1 of the "POLLUX"; and
- the outdoor and indoor storage sites.

These samples were sent to private laboratories in Quebec and Ontario. The results of the analyses of these two laboratories were unable to confirm that the potlining emitted flammable gases in contact with water, and the product could therefore not be classified 4.3 in the Classification of the International Maritime Dangerous Goods Code.

Because of this contradiction between the results of the laboratory analyses and the fact that there was an explosion, the Transport Canada Marine Casualties Investigations Division commissioned the Federal Department of Energy, Mines and Resources to pursue the laboratory analyses further and resolve the contradiction.

The results of these government laboratory analyses demonstrate conclusively the release of explosive gases such as hydrogen and methane when potlining comes into contact with water. The results were the same for the three (3) samples taken, that is from hold No. 1 of the "POLLUX" and from both the indoor and outdoor sites. In all cases hydrogen and methane gas were given off.

The report also confirms that by calculation there was sufficient energy in the explosion of the hydrogen and methane gas to propel the No. 1 hold hatch covers very high into the air. The covers which fell on the tugs ahead of the "POLLUX" weighed a total of 30 tons and were projected some 50 metres forward and over the bow of the vessel.

As for the source of ignition, the government report states that it was probably a spark from the switch of the motor driving the hydraulic system for opening and closing the No. 1 hatch covers that triggered the explosion. The damage to an electrical box in the No. 1 fan room supports this theory.

18. <u>State of cargo</u>

Some photographs taken the day of the explosion show a pile of spent potlining at the outdoor site standing in a slick of water. Other photographs show a shovel loader filling the steel containers with spend potlining for transport to the "POLLUX". Further, according to the Quebec meteorological station for the Saguenay region, from March 13 to 19 there were some 20 mm of precipitation, and on the day of March 14,

1990, alone, while loading was taking place into hold No. 1, 8 mm of rain fell on the region.

There is no doubt that the spend potlining loaded into hold No. 1 had a high moisture content, and, according to the material data sheet, decomposition of spent potlining is dangerous in contact with water, releasing ammonia and explosive gases.

19. Condition of hold No. 1

The No. 1 hatch had been closed and unventilated since noon on March 15 with some 2,150 mt of spent potlining stowed inside, and the explosion occurred on March 19, 1990, at or about 1425. This means that a mixture of hydrogen and methane gas built up over four (4) days inside the fan room and in hold No. 1. According to the laboratory report, at the time of the explosion there was sufficient explosive gas present to propel the hatch covers weighing in all a total of 110 tons, as well as the two hydraulic cylinders, into the air.

20. Source of ignition

The "POLLUX" was equipped with MacGregor hatch covers. The four (4) magnetic starter boxes for the hydraulic pumps for operating the No. 1 hold hatch covers were located in the fan room aft of the hold. The system's start buttons are easily accessible from the deck by way of the starboardside trunk just abaft hold No. 1. By leaning over the trunk and stretching out an arm, a person can easily reach the push buttons (see photograph illustrating this procedure) and thus start the hydraulic system.

A damage inspection, conducted to determine what the source of ignition of the explosive gases could be, revealed that 2 of the 4 magnetic starter boxes for the hydraulic pumps were damaged. As one of the distribution boxes was heavily damaged, and the other untouched, the internal damage suffered to the box was deduced to be due to a gas explosion inside the box. The resulting flame reached hold No. 1 through the air vents and ignited the gases there, causing a violent explosion. The electrical equipment inside the fan rooms was not gastight.

The injuries and burns sustained by the second officer correspond to those that someone might receive from leaning over the hatch trunk to turn on the hydraulic system at the time of the explosion. Photographs show that the second officer's body fell back over some debris on the deck not far from the hydraulic controls for opening hold No. 1.

21. Documentation

The "POLLUX" had aboard the International Maritime Organization Dangerous Goods Code, volumes 1 to 5 inclusive, and the IMO Code of Safe Practice for Solid Bulk Cargoes with the 1985 supplement.

22. Shipping of spent potlining by sea without incident

Since the spring of 1989 some 70,000 mt of spent potlining have been shipped from another Quebec port, Baie Comeau, by sea without incident. The spent potlining shipped had been stored indoors. It was immediately transported from the delining room to a naturally ventilated building.

When these 70,000 mt were being shipped, no sampling was done to determine the moisture content of the spent potlining. However, as the product was always sheltered from the weather and stored in a ventilated building, it can only be assumed that the moisture content must have been lower than for exposed spent potlining.

23. Damage to vessel

The major damage sustained by the Norwegian vessel "POLLUX" may be summarized as follows:

- the switches for the No. 1 hold fans, located inside the ventilation shaft, were destroyed by the blast from the explosion, as were all fittings in this area,
- the electronic components of the hydraulic system were destroyed;
- all the No. 1 hold fans were blown off their seatings and scattered in pieces inside the compartment;
- all the No. 1 hold bulkheads suffered heavy damage and were torn from their positions;
- the top of the fuel tank lying between holds No. 1 and No 2 was torn off.
- the No. 1 crane was destroyed, and No. 1 hatch and its cover panels were heavily damaged.

24. Control zone

The blast from the explosion was heard more than 1 kilometre away and all crew members and harbour personnel were quickly evacuated from the area. A control zone was quickly set up

by Alcan's safety officers. The employees of Stone Consolidated, whose facilities are located not far from the scene of the explosion, also had to be evacuated from the area.

The area remained inaccessible for several days while a team of specialists attempted to neutralize hold No. 2, which was still closed and had 5,400 mt of spent potlining inside.

The La Baie police, firemen and emergency preparedness team members came to the scene. The Ports Canada authorities were advised of the explosion after the event, but were not subsequently consulted, even though the "POLLUX" was located in waters under Ports Canada jurisdiction.

The rapid intervention of harbour rescue workers in assisting the injured and in organizing their transportation to hospital was commendable.

Tests revealed that hold No. 2 contained high levels of explosive gases. It was subsequently decided to inject CO_2 gas into the hold so as to reduce the level of explosive gases before attempting to open the hatch using the hydraulic system.

During the morning of March 24, the hatch covers were successfully raised a few centimetres to allow natural ventilation before opening them up completely. During this time the control zone had been reduced and some employees at the Stone Consolidated plant were able to return to work.

The vessel was then unloaded and the potlining was transported back to the Jonquière plant site.

The "POLLUX" subsequently left La Baie for Quebec City on May 6 prior to proceeding to Port Weller, Ontario, for permanent repairs.

25. <u>Qualifications and experience</u>

a. The master of the Norwegian vessel "POLLUX" holds a Norwegian Master Mariner Certificate. He sailed as chief officer for 7 years and has been master since 1969. At the time of the explosion on March 19, 1990, he had been master of "POLLUX" since January 1990. His experience was exclusively aboard cargo vessels. He has some 12 years' experience of navigating the St. Lawrence River and the Seaway. He also has experience of navigating in ice on the St. Lawrence River. At no time in his career had he been required to carry a cargo of dangerous goods.

b. The chief officer had been sailing since 1975 and had been a chief officer since 1983. He held a Filipino Mate Foreign-Going Certificate, issued in 1983. At no time in his career had he been required to carry a cargo of dangerous goods. He had been chief officer on board "POLLUX" since January 1990.

c. All the other officers of the "POLLUX" were duly qualified and have had several years of experience at sea.

Findings

It would appear that the explosion on board the Norwegian vessel "POLLUX" on March 19, 1990, was due to an accumulation of explosive gases in hold No. 1, and that an ignition initiated an explosion which caused the deaths of two (2) crew members and seriously injured one (1) other.

The following factors are considered to have contributed to the accident:

- the cargo of spent potlining stowed into hold No. 1 came from a site that was not protected from the weather;

- rain was permitted to fall on the unprotected potlining further increasing its moisture content;

- the cargo's high moisture content caused ammonia and explosive gases (hydrogen, methane) to be released inside hold No. 1;

- an accumulation of a mixture of explosive gases spread through hold No. 1, which was closed and unventilated, and infiltrated into the fan room;

- the mixture of explosive gases was then ignited by an electric spark when the hydraulic pumps for opening the hatch covers were started up.

Other Findings

The term "spent potlining" is not familiar to the shipping industry, and the substance is neither documented nor regulated.

Communication between the shipper, the charterer and the "POLLUX" did not identify information on the physical and chemical properties of spend potlining but which properties were known to the shipper.

The master expressed concern about the cargo to the harbour authorities but he was assured that the cargo was merely a waste product and harmless.

The planning for this shipment of spent potlining was based on the Transportation of Dangerous Goods Act rather than on the Canada Shipping Act.

Class 6.1 for spent potlining does not appear to be the appropriate classification for this kind of material.

The first two laboratory tests show that the IMO standards for classifying dangerous products may be inadequate for some products similar to spent potlining.

As the electrical circuits inside the fans rooms were not gastight, the "POLLUX" was not a suitable ship for this kind of cargo.

Ports Canada was not advised by either the shipper or the vessel's agent that this loading of spent potlining was taking place in the waters of Baie des Ha! Ha!

A marine emergency plan had not been drawn up between the private harbour facilities in Baie des Ha! Ha! and Ports Canada.

The information on Alcan's harbour facilities for vessels calling at them makes no mention of the fact that the port falls under the jurisdiction of Ports Canada and that vessels are subject to Ports Canada Operating By-laws.

Transportation Safety Board of Canada
Investigation - Marine
P.O. Box 9120
Alta Vista Terminal
Ottawa, Ontario
K1G 3T8

JULY, 1991

ANNEX I

i

THE EXPLOSION ON THE SHIP "POLLUX" AT PORT ALFRED, QUEBEC, MARCH 19, 1990: A LABORATORY INVESTIGATION

by

K.J. Mintz*

ABSTRACT

"Spent potlining", also called potlining mix, etc., a waste product from Alcan, became wet prior to and during loading of the ship, generating explosive gases. The explosive gas mixture in the cargo hold was probably ignited by an electric spark from the switchbox controlling the hatch cover. Laboratory tests confirmed that spent potlining do produce explosible quantities of hydrogen and methane by reaction with water. Details of the tests are provided in this report. However, the United Nations tests for "substances which, in contact with water, emit flammable gases" (Dangerous Goods, Division 4.3) indicate that spent potlining should not be so classified. An analysis of the U.N. tests for this category shows that they are inadequate; it is recommended that these tests be revised, both in procedure and in the limits specified.

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*Research Scientist, Canadian Explosive Atmospheres Laboratory, Mining Research Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa

ANNEX II

MATERIAL SAFETY DATA SHEET

IDENTIFICATION

PRODUCT NAME : SPENT POTLINING

AHMS NUMBER : A0026 REVISION DATE : 07/03/90

SUPPLIER :
ALCAN SMELTERS AND CHEMICALS LTD
SUBSIDIARY OF :
ALCAN ALUMINIUM LTD
1188, SHERBROOKE WEST BUSINESS PHONE: (514) 848-8000
MONTREAL (QUEBEC), CANADA EMERGENCY PHONE: (514) 848-1454
H3A 3G2

SYNONYMS :
SPENT CATHODES; POTLINING; BRASQUE USEE
REBUS DES CATHODES (SALLES DE CUVES);
SPENT POTLINING; WASTE OF CATHODS (POTROOMS)

APPEARANCE & ODOR :
SOLID GREY-BLACK WITH AMMONIA ODOR IF WET

USES :
WASTE PRODUCTS

INGREDIENTS

NAME	CONC.	CAS
CARBON	26-72%	7440-44-0
TOTAL SODIUM	13-17%	
FLUORIDES	7-22%	
CYANIDES	<0.7%	151-50-8
ALUMINUM (AL)	5-20%	7429-90-5
ALUMINA (AL2O3)	11-22%	1344-28-1
CALCIUM OXIDE (CAO)	< 3%	1305-78-8
SILICATES	<10%	
IRON OXIDE (FE2O3)	<1.4%	1309-37-1
MAGNESIUM OXIDE (MGO)	<.35%	1309-48-4
TOTAL SULFUR	<0.2%	

DOES NOT CONTAIN ANY CARCINOGENS OR POTENTIAL CARCINOGENS -IARC,NTP,OSHA

WHMIS CLASSIFICATION: D2B

PHYSICAL DATA

EVAPORATION RATE	: N/A	(N/A	=1)		
BOILING POINT	: N/A	'C		VAP. DENSITY	: N/A (AIR =1)
MELTING POINT	: N/D	'C		SPEC. GRAVITY	: 2.0-2.5(WATER =1)
VAPOUR PRESSURE	: N/A	mmHg	'C	PARTIC. SIZE	: N/D
% VOLATILE (VOL)	: N/A			WATER SOLUBI.	: N/D g/l
				PH	: N/A

FIRE & EXPLOSION HAZARD

FLASH POINT	: (N/A)	N/A	'C	NFPA CODE : 1
AUTO-IGNITION TEMP	:	N/A	'C	
FLAMMABLE LIMITS	: LOW.:	N/A	%	
	UPP.:	N/A	%	

EXTING.MEDIA AND SPECIAL TECHN.:

COMBUSTIBLE.
DRY CHEMICAL AGENTS (CO2). DO NOT USE WATER.
SPREAD THE PRODUCT OUTSIDE AND COVER WITH SAND.
WEAR A SELF-CONTAINED BREATHING APPARATUS AS NECESSARY.
DO NOT USE WATER, THE REACTION WILL EMIT AMMONIA AND EXPLOSIVE GASES.

REACTIVITY

STABLE: X UNSTABLE:

CONDITIONS & MATERIAL TO AVOID:
AVOID CONTACT WITH WATER, ACIDS, BASES AND INTENSE HEAT.

HAZARDOUS POLYMERIZATION:
N/A

HAZARDOUS DECOMPOSITION:
AMMONIA AND EXPLOSIVE GASES (HYDROGEN, METHANE AND ACETYLENE) CAN BE RELEASED IF THE PRODUCT COMES IN CONTACT WITH WATER OR ALKALIS. FLUORIDES, HYDROGEN FLUORIDE, HYDROGEN CYANIDE AND OXIDES OF SULFUR CAN BE RELEASED IF THE PRODUCT COMES IN CONTACT WITH HIGH TEMPERATURES OR ACIDS.

HEALTH EFFECTS

ROUTES OF ENTRY	: INHALATION	: X		INGESTION	:X
	EYE CONTACT	: X		SKIN	:X
TARGET ORGAN(S)	: RESPIRATORY TRACT		BONES		
	DIGESTIVE SYSTEM		EYES		

SKIN

ACUTE TOXICITY:

INHALATION:

SEVERE IRRITATION OF THE RESPIRATORY TRACT.
IF HIGH CONCENTRATIONS OF AMMONIA ARE RELEASED, THEY CAN CAUSE BRONCHO-SPASM, DYSPNEA AND CHEST PAIN.

SKIN CONTACT:

IRRITATION.
FREE CYANIDES MAY BE ABSORBED THROUGH WET SKIN.

EYE CONTACT:

IRRITATION AND BURN.

INGESTION:

IRRITATION OF THE GASTRO-INTESTINAL TRACT, NAUSEA, VOMITING; IF THE AMOUNT INGESTED IS HIGH, DEATH CAN OCCUR.

CHRONIC TOXICITY:

PROLONGED OVEREXPOSURE TO FLUORIDES MAY INCREASE RADIOGRAPHIC DENSITY OF BONES AND TEETH AND WHICH CAN RESULT IN FLUOROSIS.

.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE TO THE PRODUCT:
RESPIRATORY DISEASES.

SUPPLEMENTARY INFORMATION :

FOR PERSONS HABITUALLY EXPOSED TO THE DUST, AN ANNUAL PHYSICAL EXAM SHOULD BE GIVEN INCLUDING MEASUREMENT OF URINARY FLUORIDE.

THE AMOUNT OF URINARY FLUORIDE SHOULD NOT EXCEED 4 PPM (PRE-SHIFT) OR 7 PPM (POST-SHIFT).

EXPOSURE LIMITS :

	ACGIH (TLV)		OSHA (PEL)	
	TWA	STEL	TWA	STEL
FLUORIDE (AS F)	2.5 MG/M3	ND	2.5 MG/M3	ND
ALUMINUM (TOT.DUST)	10 MG/M3	ND	15 MG/M3	ND
-FUME,POWDER,RESP.DUST	5 MG/M3	ND	5 MG/M3	ND
ALUMINUM OXIDE (TOT.DUST)	10 MG/M3	ND	10 MG/M3	ND
-RESP. DUST	ND	ND	5 MG/M3	ND
IRON OXIDE FUME	5 MG/M3	ND	10 MG/M3	ND
MAGNESIUM(OXIDE+FUME TOT)	10 MG/M3	ND	15 MG/M3	ND
-RESP. DUST	ND	ND	5 MG/M3	ND
CYANIDE (AS CN)	5 MG/M3	ND	5 MG/M3	ND
HYDROGEN CYANIDE	10 PPM	10 PPM-CEIL	ND	4.7 PPM
CALCIUM OXIDE	2 MG/M3	ND	5 MG/M3	ND
SILICATES,AMORPHOUS	10 MG/M3	ND	6 MG/M3	ND
AMMONIA (NH3)	25 PPM	35 PPM	ND	35 PPM

FIRST AID MEASURES

INHALATION:
IN CASE OF DISCOMFORT BY VAPORS OR DUSTS, MOVE TO A VENTILATED AREA.
CONSULT A PHYSICIAN.
SKIN CONTACT:
REMOVE CONTAMINATED CLOTHES. WASH SKIN THOROUGHLY WITH SOAP AND WATER.

EYE CONTACT:
FLUSH EYES WITH ABUNDANT QUANTITIES OF WATER AND WASH CAREFULLY UNDER EYELIDS. CALL A PHYSICIAN.
INGESTION:
GIVE PLENTY OF WATER. INDUCE VOMITING IF THE PERSON IS CONCIOUS.

PREVENTIVE MEASURES

PERSONAL PROTECTION:
USE LOCAL AND GENERAL EXHAUST VENTILATION TO KEEP CONCENTRATIONS AS LOW AS POSSIBLE.
USE A DUST MASK AND/OR A RESPIRATOR WITH AMMONIA AND PARTICULATE FILTERS IF AIRBORNE CONCENTRATIONS EXCEED THE THRESHOLD LIMIT VALUES.
WEAR PROPER PROTECTIVE CLOTHING TO AVOID CONTACT WITH WET SKIN.

USE NEOPRENE GLOVES TO AVOID SKIN CONTACT.

CHANGE WORK CLOTHING IF CONTAMINATED.

HANDLING METHODS:
KEEP THE MATERIAL DRY.
AVOID ALL SKIN AND EYE CONTACT.

STORAGE REQUIREMENTS:
STORE AWAY FROM ACIDS, BASES AND OXIDIZING MATERIALS.
STORE IN A COOL, DRY AND WELL-VENTILATED AREA.

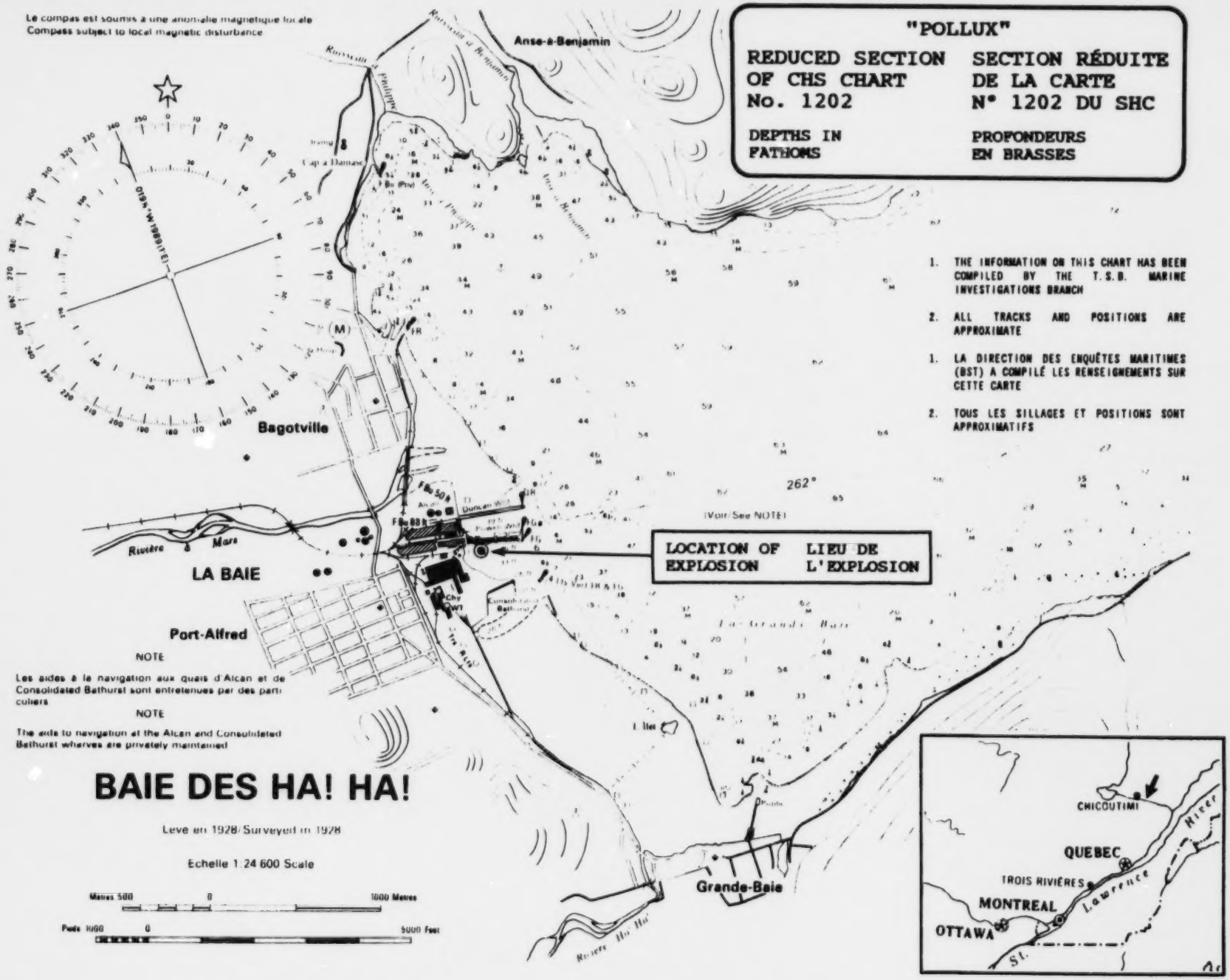
SPILL, LEAK, DISPOSAL PROC.:
KEEP THE MATERIAL DRY.
SHOULD THE MATERIAL BECOME MOIST, ENSURE THE PH IS ALKALINE.
SMALL SPILL:
PUT INTO APPROPRIATE CONTAINERS.
AVOID POLLUTION OF SURFACE WATER, STREAMS OR SEWERS.

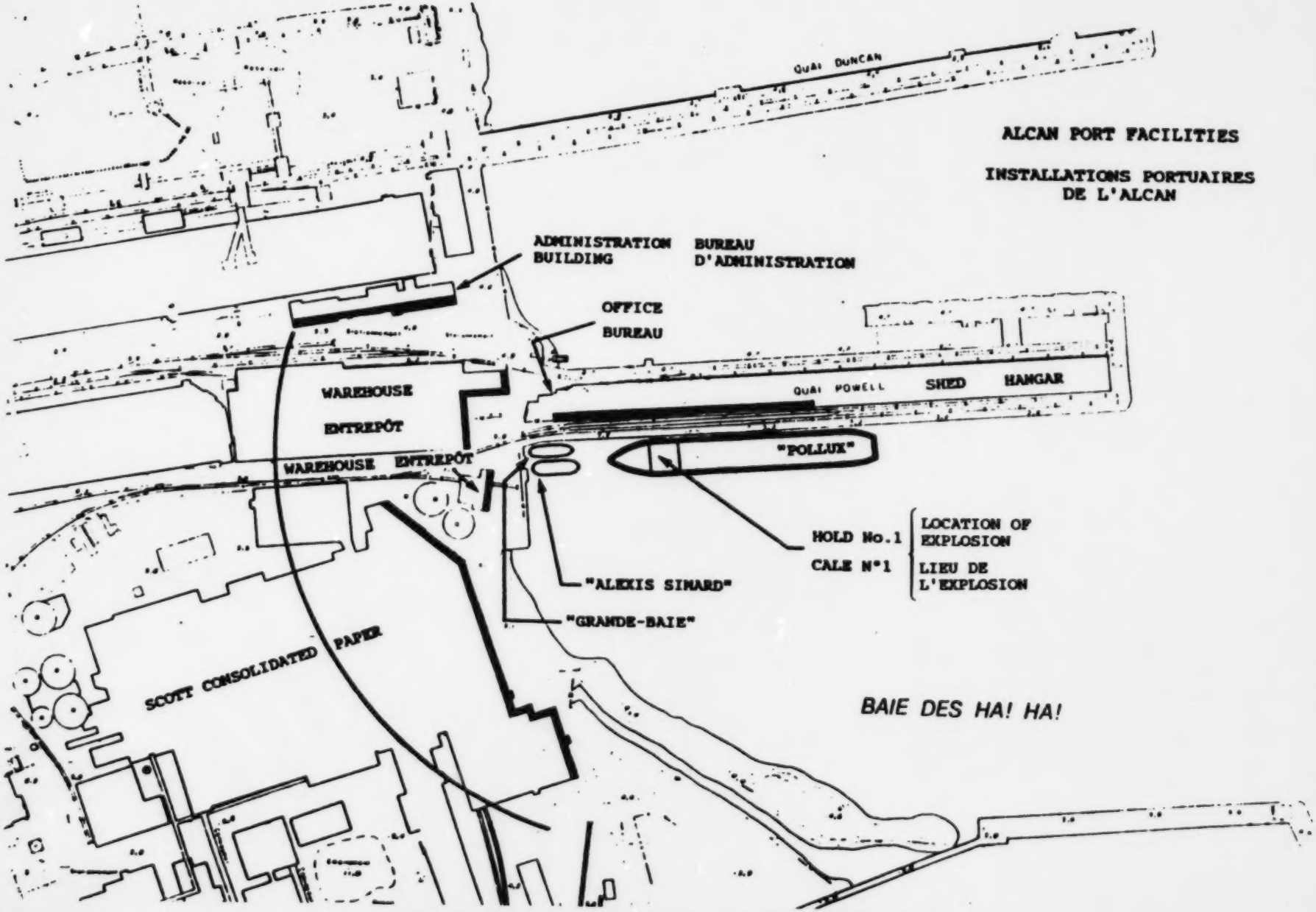
WASTE PRODUCTS SHOULD BE TESTED TO DETERMINE ANY HAZARDOUS CHARACTERISTICS.
DISPOSE OF THE WASTE IN ACCORDANCE WITH FEDERAL, STATE OR LOCAL WASTE DISPOSAL REGULATIONS.

ADDITIONAL INFORMATION:
THE INFORMATION IN THIS MSDS WAS OBTAINED FROM SOURCES WHICH WE BELIEVE ARE RELIABLE BUT CANNOT GUARANTEE. ADDITIONALLY, YOUR USE OF THIS INFORMATION IS BEYOND OUR CONTROL AND MAY BE BEYOND OUR KNOWLEDGE. THEREFORE, THE INFORMATION IS PROVIDED WITHOUT ANY REPRESENTATION OR WARRANTY EXPRESS OR IMPLIED.

PREPARED BY ALCAN TOXICOLOGY SERVICE
P.O. BOX 1500 JONQUIERE (QUEBEC), CANADA, G7S 4L2 - 418-699-3907
FAX NO: 418-699-2993

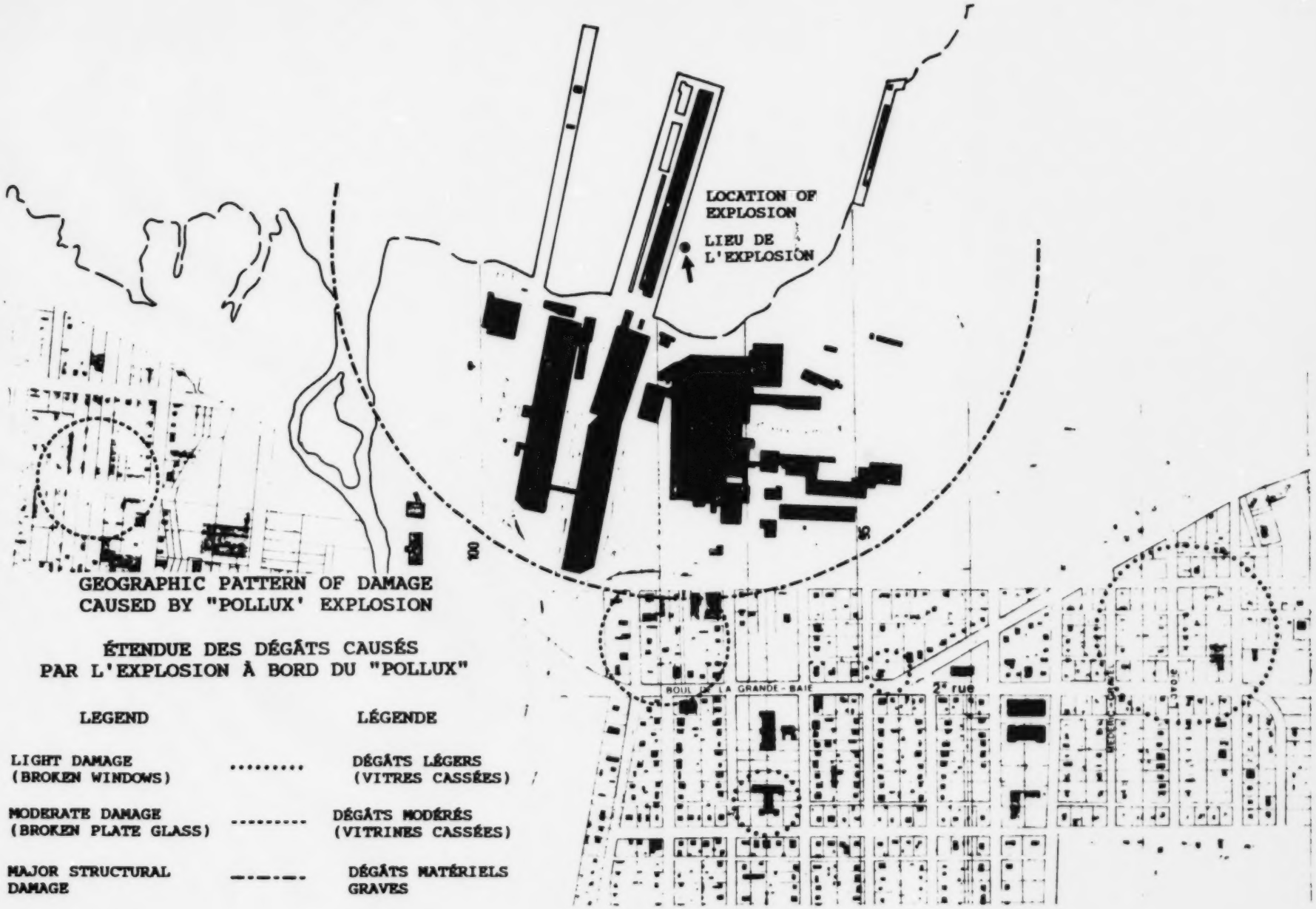
N/A : NOT APPLICABLE N/D : NOT DETERMINED DC : DECOMPOSES


Le compas est soumis à une anomalie magnétique locale
Compass subject to local magnetic disturbance
"POLLUX"
REDUCED SECTION OF CHS CHART No. 1202
SECTION RÉDUITE DE LA CARTE N° 1202 DU SHC
DEPTHS IN FATHOMS
PROFONDEURS EN BRASSES
1. THE INFORMATION ON THIS CHART HAS BEEN COMPILED BY THE T.S.B. MARINE INVESTIGATIONS BRANCH
2. ALL TRACKS AND POSITIONS ARE APPROXIMATE
1. LA DIRECTION DES ENQUÊTES MARITIMES (BST) A COMPILÉ LES RENSEIGNEMENTS SUR CETTE CARTE
2. TOUS LES SILLAGES ET POSITIONS SONT APPROXIMATIFS
Anse-à-Benjamin
Bagotville
LA BAIE
Port-Alfred
Rivière à Mars
LOCATION OF EXPLOSION
LIEU DE L'EXPLOSION
(Voir/See NOTE)
262°
NOTE
Les aides à la navigation aux quais d'Alcan et de Consolidated Bathurst sont entretenues par des particuliers
NOTE
The aids to navigation at the Alcan and Consolidated Bathurst wharves are privately maintained
BAIE DES HA! HA!
Levé en 1928/Surveyed in 1928
Echelle 1:24 600 Scale
Mètres 500 0 1000 Mètres
Pieds 1000 0 5000 Feet
Grande-Baie
CHICOUTIMI
QUEBEC
TROIS RIVIÈRES
MONTREAL
OTTAWA
Lawrence
St.



SHOWING AREAS WHICH BORE BRUNT OF EXPLOSION

MONTRANT LES ENDROITS OÙ LE CHOC DE L'EXPLOSION A ÉTÉ LE PLUS VIOLENT



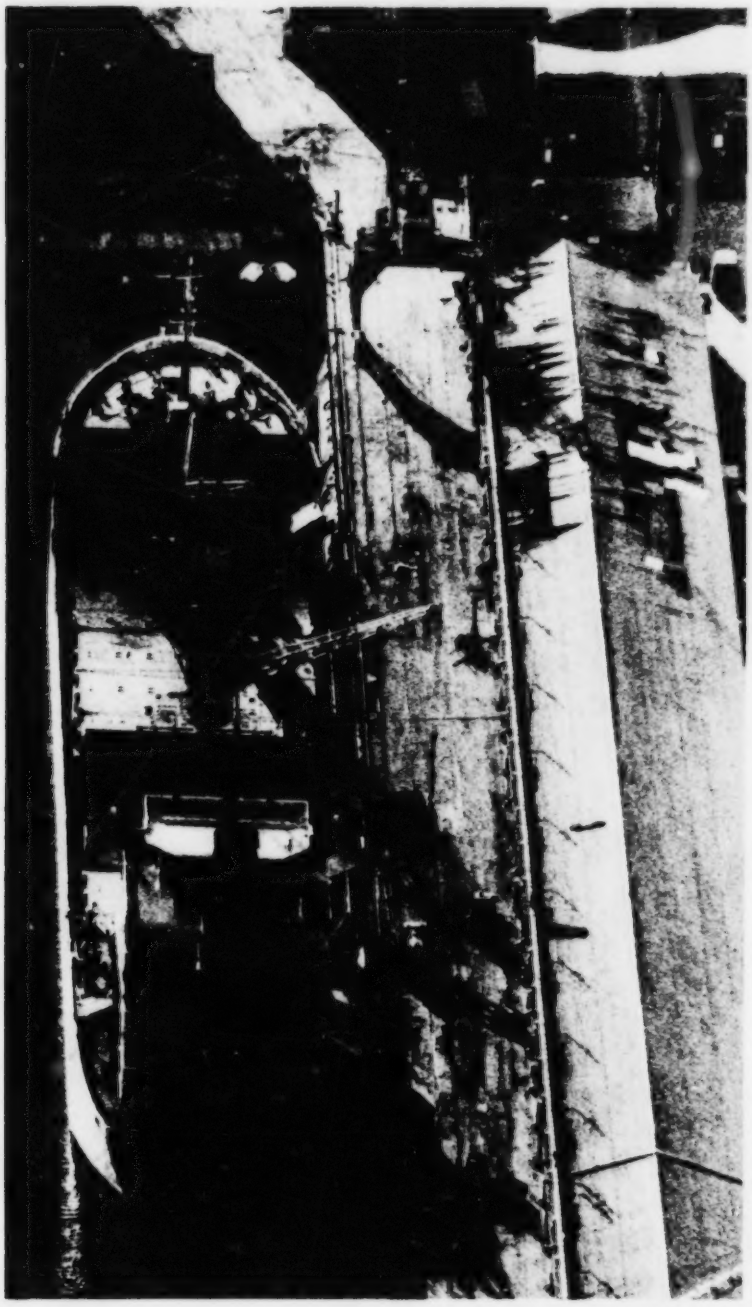
GEOGRAPHIC PATTERN OF DAMAGE CAUSED BY "POLLUX' EXPLOSION

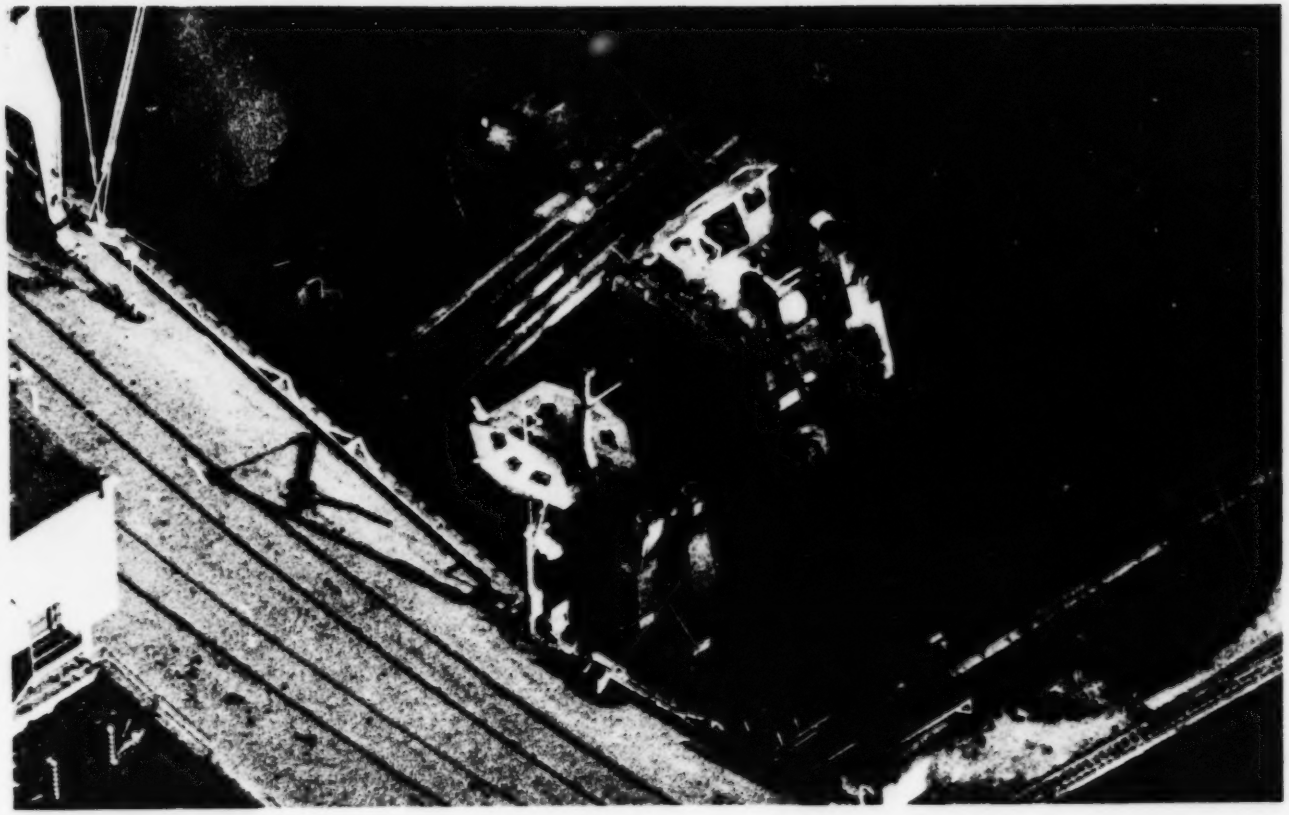
ÉTENDUE DES DÉGÂTS CAUSÉS PAR L'EXPLOSION À BORD DU "POLLUX"

LEGEND		LÉGENDE
LIGHT DAMAGE (BROKEN WINDOWS)	.....	DÉGÂTS LÉGERS (VITRES CASSÉES)
MODERATE DAMAGE (BROKEN PLATE GLASS)	-----	DÉGÂTS MODÉRÉS (VITRINES CASSÉES)
MAJOR STRUCTURAL DAMAGE	-.-.-.	DÉGÂTS MATÉRIELS GRAVES

Aerial view of the "POLLUX" alongside Powell wharf after the explosion

Vue aérienne du navire "POLLUX" au quai Powell après l'explosion





Hatch covers which were propelled from no. 1 hold
on the "POLLUX" landed on the two harbour tugs

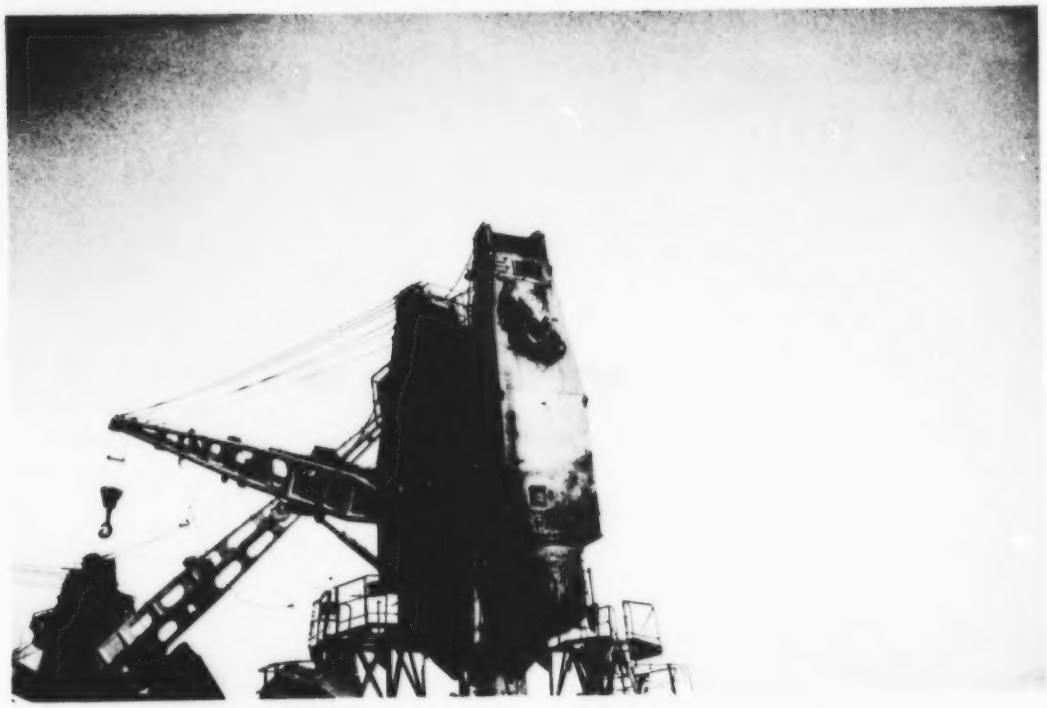
Panneaux d'écoutilles projetés de la cale N° 1
du "POLLUX" vers les deux remorqueurs portuaires

Hatch covers from the "POLLUX" on the two harbour tugs

Panneaux d'écoutilles du "POLLUX" sur les deux remorqueurs portuaires

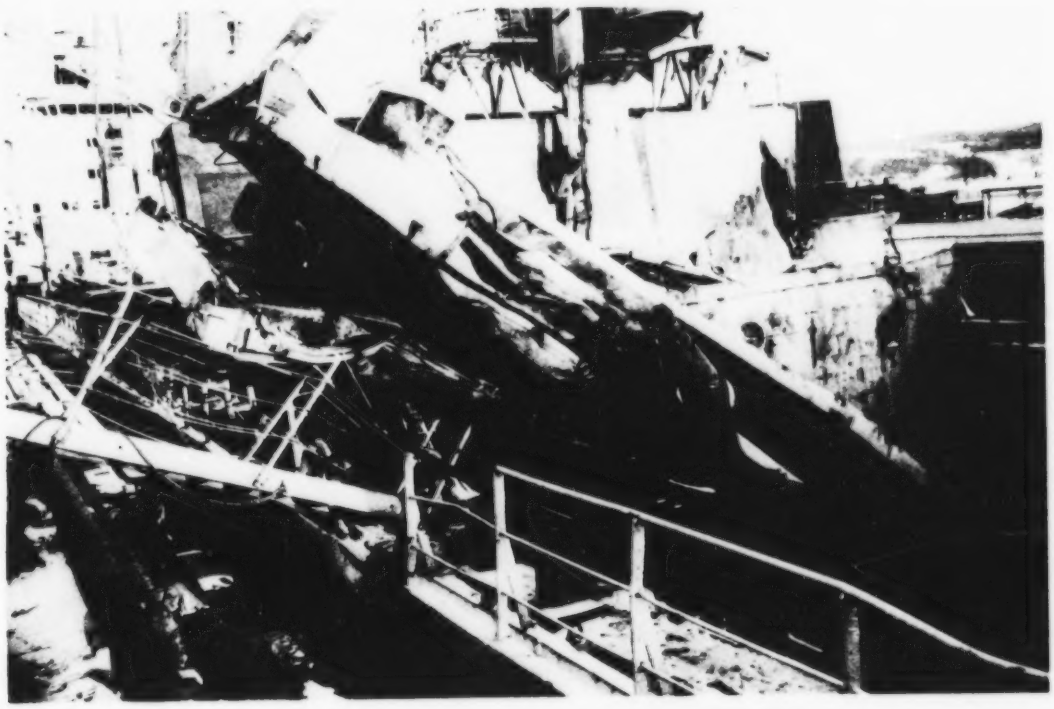
Damage on the "POLLUX"

Avaries au navire "POLLUX"



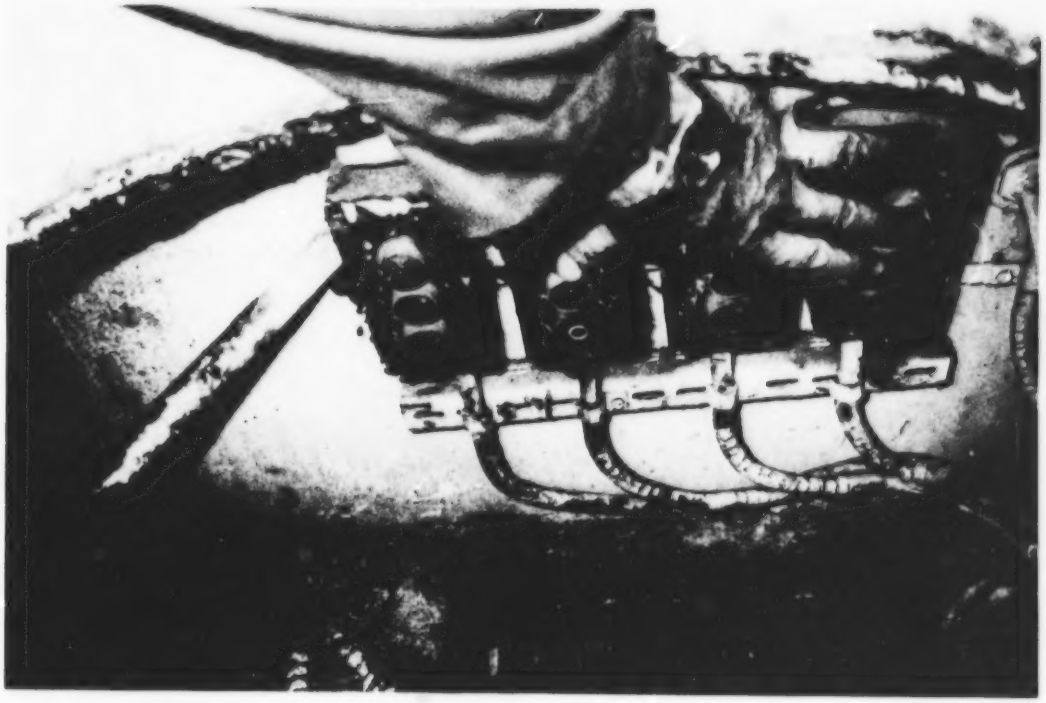
No. 1 crane with cab crushed and jib missing

Grue # 1 sans flèche et avec cabine écrasée



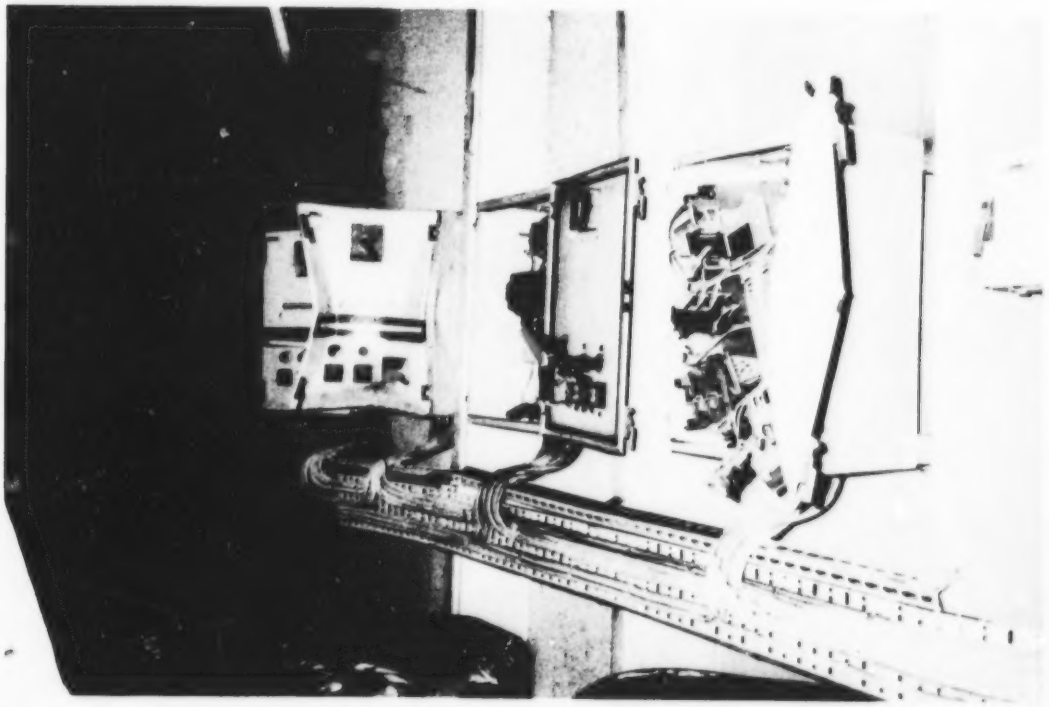
Starboard side in way of no. 1 hatch

Côté tribord près de l'écoutille # 1



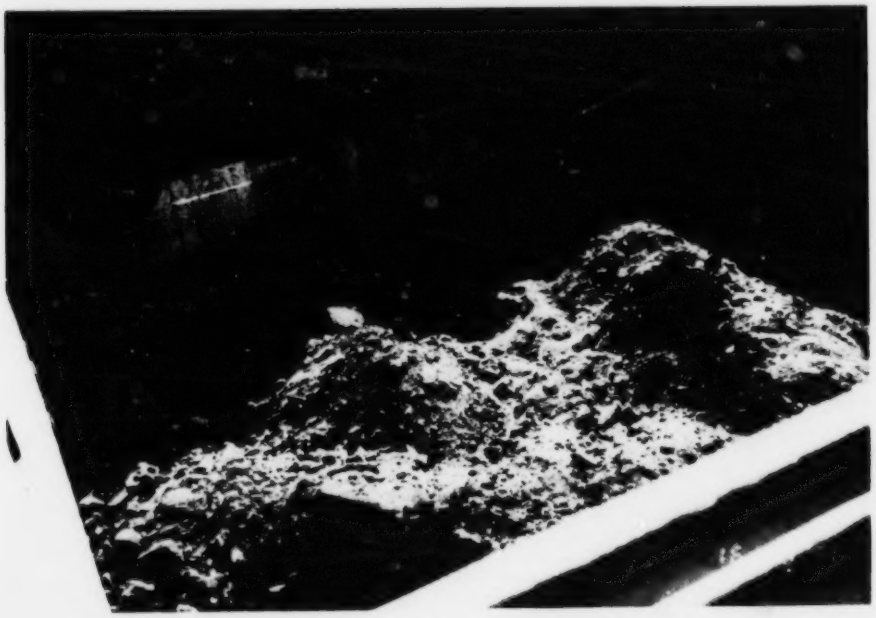
Push button controls to hydraulic pumps for operating no. 1 hatch covers

Boutons poussoirs pour démarrer les pompes hydrauliques pour l'écoutille # 1



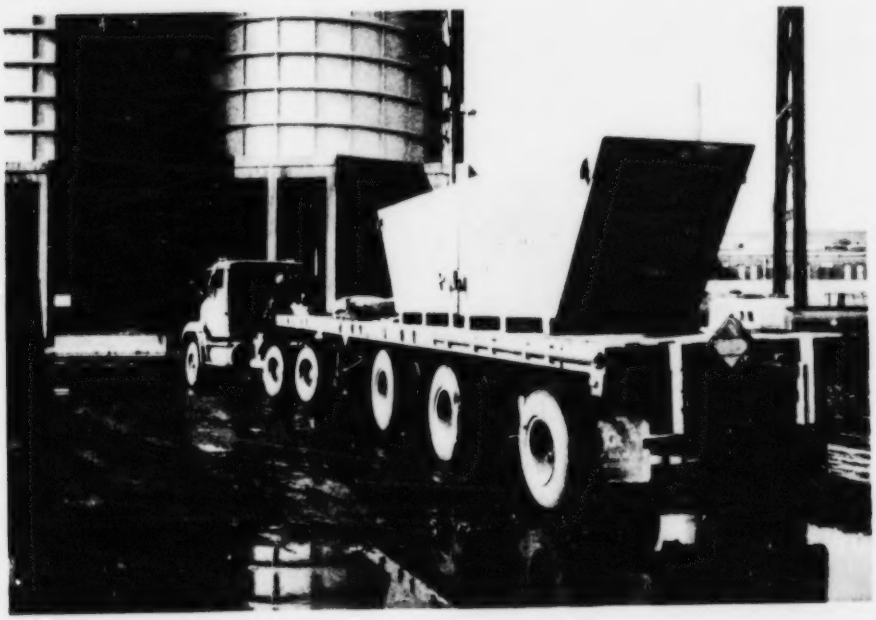
Contactor boxes for the hydraulic pumps

Boîtes de contacteur pour pompes hydrauliques



Spent potlining stowed in hold of the "POLLUX"

Brasque usée arimée dans une des cales du "POLLUX"



Transport to the vessel by truck

Le transport par camion